Report for 2002NV6B: A Long-Term Comparative Study of Golf Courses Irrigated with Reuse vs. Municipal Water

- Articles in Refereed Scientific Journals:
  - Morris, R.L. and D.A. Devitt. 2002. Taking a Water Sample. Part I. Southwest Trees and Turf. 7(12): 6.
  - Devitt D.A., R.L. Morris and D.S. Neuman. Impact of Water Treatment On Foliar Damage of Ornamental Trees Sprinkle Irrigated with Reuse Water. J. Environmental Horticulture (In Press, June 2003).
- Conference Proceedings:
  - Morris, R.L. and D.A. Devitt. 2002. Establishing A Nitrogen Balance Sheet. Southwest Trees and Turf. 7(11): 12.

Report Follows:

Problem and Research Objectives:

As the population in southern Nevada grows, greater demands will be placed on the available water resources. Addressing this water supply-demand dilemma will require water managers to look at all possible water sources, even waters of lower quality. Utilization of treated sewage effluent (known as reuse water) for landscape irrigation purposes is an environmentally acceptable alternative to discharging to the Las Vegas Wash and reduces the need to expand both the water delivery and sewage discharge systems (viable economic alternative). However, utilizing poorer quality waters for irrigation purposes requires state of the art, science-based management practices. Fortunately for the urban sector, no form of irrigated agriculture consistently meets these requirements better than golf courses.

Specific Objectives:

1. Collection of baseline soil-plant-water data to assess the existing status of golf courses currently being irrigated with reuse water, golf courses transitioning to reuse water in the near future and golf courses that have in the past and will continue in the future to be irrigated only with municipal water.
2. Long-term monitoring (minimum of 3 years) of salt, nitrogen and water in the soil-plant system of golf courses irrigated with reuse water vs. municipal water.
3. Development of response curves to delineate if significant shifts from the baseline occur and project the time in which critical soil and plant threshold values might be reached.
4. Development of management strategies to prevent or minimize any potential negative soil plant response should the threshold values be exceeded.

Methodology:

Nine golf courses in the Las Vegas Valley were selected for a three-year monitoring program. Selection was based on 1) willingness of golf course superintendents to participate in the study, and 2) three courses selected based on long-term (>7 years) irrigation with reuse water, three courses selected based on a projected transition to reuse water within the next two years and three courses selected based on no anticipated switch to reuse water within the foreseeable future. Golf course superintendents were surveyed at the beginning of the monitoring period and annually, over a number of issues regarding the use of reuse water. Superintendents were asked to 1) characterize the golf course in terms of type of course, current management practices and budget allocations, 2) describe any attitude changes in the use or acceptance of reuse water, 3) quantify economic impact that the use of reuse water has on their operations and 4) list changes in management practices that occur as reuse water is utilized.

Fairways, greens and mixed landscape areas are being monitored at each golf course. Soil samples are taken in a 5 x 5 grid within irrigation cells located on the fairway and green of one hole of each of the nine courses. Soil samples are also taken adjacent to trees, shrubs and flowering annuals in the mixed landscape area of the same hole. Soil samples are being taken from the 0-15 cm depths. Soils are being analyzed using the saturation extract procedure outlined by the U.S. Salinity Laboratory (1954). All extracts are being

analyzed for salinity, pH and all major cations and anions (including ammonium and nitrate). Grid locations are also analyzed using an EM38 device to measure bulk soil conductance. The bulk soil conductance is being correlated with ECe and soil moisture data to develop empirical models for mapping purposes. Soil sampling will occur at the same locations (slight offset) on a yearly basis and all samples will be analyzed using the same procedures outlined for the initial sampling.

Soil salinity sensors, soil moisture sensors (time domain reflectometry – TDR), solution extraction cups and tensiometers were placed in a nested arrangement at depths of 15, 45, 75 and 105 cm at one location in the fairway, green and mixed landscape area of each golf course and measured or sampled on a bi-monthly or monthly basis.

Turf grass from the fairway and greens and plant material from the mixed landscape area is sampled in the spring of each year and on a per need basis and analyzed for major cations and anions. Leaf temperature, leaf water potential, stomatal conductance and spad-chlorophyll index are taken on a monthly basis at three locations on the fairway and greens and on trees, shrubs and flowering annuals in the mixed landscape area of each golf course. Photographs are taken monthly of the turf grass and mixed landscape areas with a digital camera. A photo library is being established for each golf course to clearly document the visual health of the plants. A visual rating system is also being used to evaluate color, cover and overall health of the turf grass and mixed landscape plant material on a monthly basis. Spectral data is collected using a multi spectral sensor during the summer of each year to develop NDVI response curves (normalized difference vegetation index, vs. nitrogen, salinity, moisture) and to assess the adequacy of the irrigation system. All irrigation cells containing sensors were evaluated for irrigation uniformity distribution. If Hart and Reynolds (1966) adjusted uniformity's were less than 0.80, adjustments in the irrigation systems were made in an effort to improve the spatial distribution.

Water samples are collected monthly from the irrigation pond or irrigation system and from the soil solution cups and analyzed for salinity, pH and major cations and anions. Irrigation ponds are also analyzed for fecal coliform, algal content, dissolved oxygen, temperature and clarity (secchi disk) on a monthly basis.

Weather data (temperature, wind speed, solar radiation, relative humidity) is collected from on-site weather stations or nearby locations for the purpose of monitoring potential evapotranspiration.

Water meters have been placed on all laterals that deliver water to the monitoring locations on all nine golf courses. Meter readings are taken bi-monthly. Precipitation curves (time-pressure-volume) were established using collection cans placed in a grid pattern for all irrigation cells containing sensors. Actual precipitation associated with each irrigation event is predicted using the established curves for each site.
Water balances are maintained by monitoring irrigation input and estimating water loss via evapotranspiration by adjusting potential evapotranspiration estimates with appropriate crop coefficients (Devitt et al. 1992).

All data is being statistically analyzed using analysis of variance and/or multiple regression analysis. Grid data is being kriged and contour maps are being developed for each research plot.

Principal findings and significance: (Primary Project is continuing to 2005).

Water balances closed on the nine courses indicate that many of the courses are being under irrigated, with estimated leaching fractions below 0.15. This is a concern, as five of the golf courses will eventually transition to the lower quality reuse water and all of the courses maintain irrigation uniformity coefficients of approximately 0.85. The combination of low leaching fractions and uniformity coefficients of 0.85 should lead to a non uniform spatial distribution of salts, water and plant response. Sensor monitoring indicates that salt distribution is not only a function of irrigation water quality but also a function of leaching fraction imposed. Although plant response has not indicated any major shift in water status or visual appearance, soil salinity has begun to rise on those courses that have transitioned to reuse water. It will be critical that irrigation management change once threshold soil salinity values have been approached. Continued monitoring will indicate the time required to approach/exceed soil salinity threshold values based on current irrigation management practices.

Information Transfer Activities:

Information gained from the monitoring program is being incorporated into a Cooperative Extension Wastewater Management course, presented at scientific meetings, presented to local golf course superintendents and published in Southwest Trees and Turf. Results will also be published in Cooperative Extension Fact sheets and peer review scientific journal articles once the research has been finalized.